

NMC STRATOSPHERIC ANALYSES DURING THE 1987 ANTARCTIC EXPEDITION

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INTRODUCTION

Stratospheric constant pressure analyses of geopotential height and temperature, produced as part of regular operations at the National Meteorological Center (NMC), were used by several participants of the Antarctic Ozone Expedition. This paper gives a brief description of the NMC stratospheric analyses and the data that are used to derive them. In addition, comparisons of the analysis values at the locations of radiosonde and aircraft data are presented to provide indications for assessing the representativeness of the NMC stratospheric analyses during the 1987 Antarctic winter-spring period.

THE NMC STRATOSPHERIC ANALYSES

Since 24 September 1978 daily global fields of temperature and geopotential height at eight stratospheric levels (70, 50, 30, 10, 5, 2, 1, and 0.4 mb, approximately 18 to 55 km) have been produced at NMC, Climate Analysis Center (Gelman et al 1986). This series of stratospheric analyses is separate from the NMC Global Data Assimilation System (GDAS) (Dey and Morone, 1985) analyses from 1000 to 50 mb. There are two levels (70 and 50 mb) that are analyzed both in the GDAS and stratospheric series. The GDAS analyses are available at both 00 GMT and 1200 GMT for use in the NMC numerical forecast system, while the stratospheric analyses, not part of the forecast system, are done only for 1200 GMT. Since the GDAS 70 and 50 mb analyses are within the top layer of the NMC numerical model, the limitations implicit in the top boundary are most evident there. While every analysis system has its own limitations, the analyses from the stratospheric series at 70 and 50 mb and higher are the fields that are most used for research purposes.

A principal data source for the stratospheric analyses comes from the Tiros Operational Vertical Soundings (TOVS) derived from the NOAA satellites. The TOVS system (Smith et al, 1979) is made up of the Stratospheric Sounding Unit (SSU), the High Resolution Sounder (HRS-2), and the Microwave Sounding Unit (MSU). The TOVS soundings derived by the National Environmental Satellite Data and Information Service (NESDIS) provide layer mean temperature between the standard pressure levels. Updating relationships used to derive temperature profiles from the satellite radiance measurements is different for different layers. For the layers from 1000 to 10 mb, the relationships (regression coefficients or eigenvectors) are based on a coincident sample of radiosonde and satellite measurements collected for the past week (or up to 3 weeks in areas of sparse data). For layers from 10 to 0.4 mb, the regression coefficients are not updated from their pre-launch values, because of lack of sufficient in-situ data to perform this function. Temperatures at the NMC stratospheric analysis levels are found by linear interpolation in log pressure of the layer mean temperatures. The geopotential heights are derived by interpolating from the GDAS field the 100 mb height to the location of each TOVS temperature profile. The hypsometric equation is then used to calculate

heights above 100 mb at each NMC analysis level.

The NMC stratospheric analyses use only TOVS data for all levels in the southern hemisphere and for 5 to 0.4 mb in the northern hemisphere. The northern hemisphere 70 to 10 mb analyses also use radiosonde data which are analyzed to modify the first guess field produced from the TOVS data.

DATA COMPARISONS

Figure 1 shows results of comparisons of radiosonde data with TOVS data colocated within 150 km and 3 hours of each other. The summaries for August, September, and October 1987 for the region 60 to 90 South shows how the average differences, especially at the upper levels, vary over this region. While some of the bias may be attributed to radiosonde error, much of the difference is due to limitations on the vertical resolution of the TOVS data and lags in the TOVS coefficients, based on recent past radiosonde data, due to rapid seasonal changes. Over most areas and pressure levels, however, the TOVS data provide very good information for use in meteorological analyses.

Figure 2 shows a comparison of temperature values from the ER-2 special flights over Antarctica during July and August 1987 with NMC analysis values interpolated to the aircraft pressure and location. Again there is very good agreement over most of the range. The large differences at higher temperatures occur at lower tropospheric levels, while the differences at the lowest temperatures are probably due to an NMC underestimate of the extremely low temperatures.

Figure 3 shows time series from mid July to mid October 1987 of 70, 50, and 30 mb temperature values interpolated from the NMC analyses to the locations of three radiosonde stations. There is reasonably good overall agreement in the temporal changes shown from the NMC values as compared with radiosonde temperatures. Most difference is seen at the upper level, consistent with the biases shown in figure 1. Correlation coefficients range from .98 at 30 mb South pole to .56 at 50 mb McMurdo.

REFERENCES

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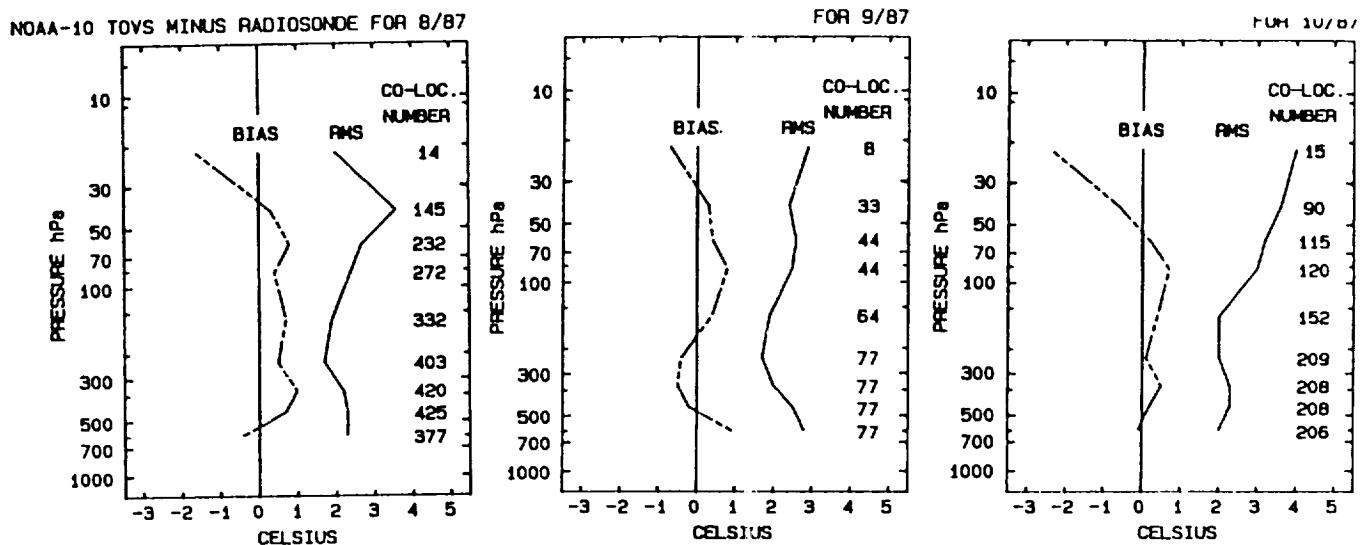


Figure 1. Temperature differences (Celsius degrees) between NOAA-10 TOVS layer mean temperatures and colocated radiosonde data from 60 to 90 S for August, September and October 1987. The number of colocations for each level appears on the right side of each diagram.

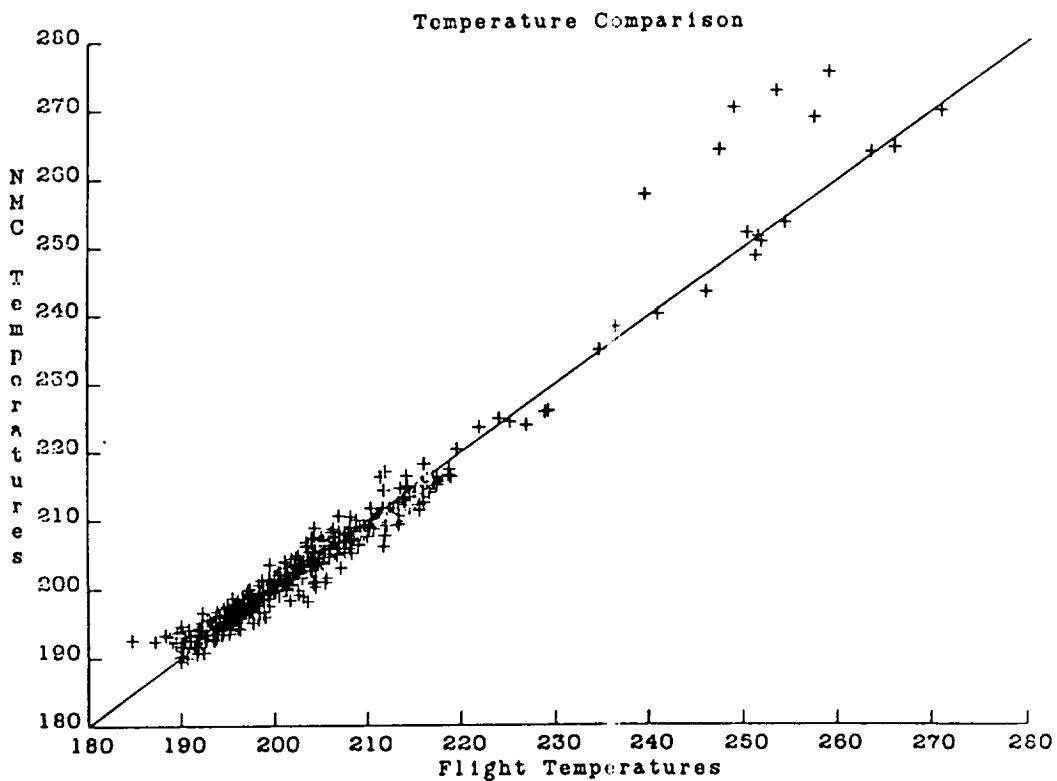


Figure 2. Comparison of temperatures from the ER-2 aircraft with interpolated NMC analysis values.

NMC ANALYSIS VERSUS RADIOSONDE

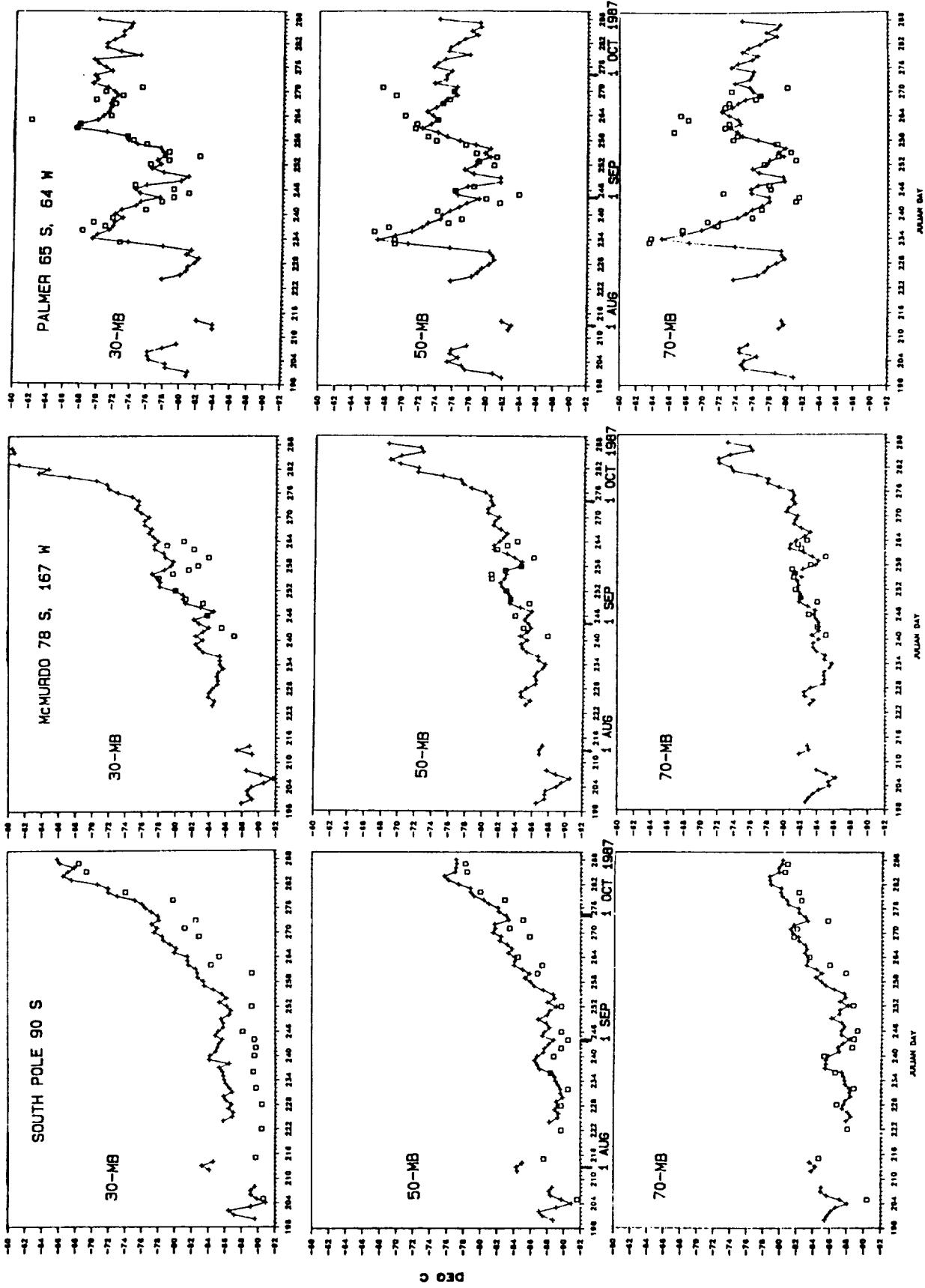


Figure 3. Comparison of 70-, 50-, and 30 mb radiosonde temperatures at South Pole, McMurdo, and Palmer with NMC temperatures interpolated to the station locations.